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ABSTRACT

Research was undertaken to investigate various methods of presentation of a computer based science simulation as it related to student content knowledge of the simulation concepts. Three treatment groups of sixth grade students were used in the study: (1) two students per computer interacting with the simulation; (2) a total class presentation of the computer simulation; and (3) a non-computer game-type presentation of the simulation concepts. Students' content knowledge was measured by a 14-item posttest administered immediately after the presentation and 6 weeks later. No statistically significant differences were found between the treatment groups, although there was a trend for higher scores for the total class presentation group on the immediate posttest multiple choice content items. However, females did less well than males on the multiple choice content items of the test. A sex by treatment group interaction was significant for the delayed posttest, with females performing better than males in the total class presentation method but less well in the paired student method. (Author/JB)

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A Comparison of Student Achievement Across Three Methods of Presentation of a Computer Based Science Simulation

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Abstract

The research to be reported was undertaken to investigate various methods of presentation of a computer based science simulations as it related to student content knowledge of the simulation concepts. Three treatment groups were used in the study; (1) two students per computer interacting with the simulation, (2) a total class presentation of the computer simulation, (3) a non-computer game type presentation of the simulation concepts. Students content knowledge was measured by a paper and several tests of fourteen items immediately after the presentation and six weeks later.

No statistically significant differences were found between the treatment groups, although there was a trend for higher scores for the total class presentation group on the immediate posttest multiple choice content items. However, females did less well than males on the multiple choice content items of the test. A sex by treatment group interaction was significant for the delayed posttest with females performing better than males in the total class presentation method but less well in the paired student method.

Introduction

The rapid growth of microcomputer utilization in schools has raised questions of appropriate methods of implementation of this technology. This study focuses on various methods of presentation of a computer based science simulation as related to student content knowledge of the simulation concepts. Simulations have been suggested as one method of microcomputer use by various authors (Lunnetta and Hofstein, 1981, Marks, 1982, Goldberg and Sherwood, 1983) .

Previous research in the use of computer simulations to replace or supplant laboratory instruction has generally shown either neutral (achievement in computer vs. non-computer settings to be equal) or increased achievement for computer settings. Studies include Cavin and Lagowski (1978) in chemistry instruction, Boblick (1972) in physics, Vockell and Rivers (1982) in biology, and Wise and Okey (1984) in Physical Science.

The increased number of computers available to teachers makes it possible that various methods of use of simulations would be possible. This research looks at three presentation methods; (1) pairs of students working on the simulation on a computer, (2) a total class working with the computer simulation, and (3) a non-computer list game type setting for the simulation. Previous research by Berger (1984) had indicated a possible positive effect for a group rather than individual use of microcomputers.

Procedure

The basic method of the study was a posttest only (both immediate and delayed) control group design with random

assignment of intact classes of students to treatment groups. The classes of sixth grade students described in the Data Sources Section were randomly assigned to one of three treatment groups. The first treatment group (N=41) was designed to use the simulation "Odell Lake" (MECC, 1981) in groups of two students per computer station. This group, as well as the second group, first participated in a pre-lab period that consisted of a group presentation and discussion of the computer based science simulation "Odell Woods". "Odell Woods" involves the relationship of animals in a wooded area in which a chosen animal encounters other animals and plants. The user of the simulation must make decisions as to appropriate actions (such as "runaway", "try to eat", etc.) to take when confronted with the other animals or plants. The senior author acted as a resource person during this session with students rotating as the keyboard users and recorders of data.

The day after the pre-lab, the first treatment group went to the school's microcomputer lab which contained 12 Apple II plus computers. The students were allowed to choose a partner and were then instructed to work on the computer based science simulation "Odell Lake". Odell Lake is similar to Odell Woods in that the student is placed in the situation of being a particular animal and then reacting to computer presented situations. Odell Lake differs in that the student only role plays various types of fish and in the fact that the graphics of the program are much more extensive than those of Odell Woods. The students were each given a data recording grid, similar in format to the data sheet used the previous dat, with all of the

various fish of the simulation on one side and all of the fish, animals, and plants that the fish might encounter on the top. It took approximately 45 minutes for all students to role play each of the six fish in the simulation. The following day the students completed the content achievement test with the aid of the data sheet they had previously prepared. In approximately six weeks a scrambled form of the content achievement test was administered.

Treatment group two (N=58) completed the pre-lab activities in a similar manner to group one. The next day this group, however, interacted with Odell Lake in a full classroom setting. A student was chosen to run the computer and the situations of the simulation were presented to the class via a large (25") monitor. Students noted by a show of hands as to which response of the six possible they wished to pick. The results of their decision were calculated by the computer program and presented on the screen. The experimenter provided the same data sheet as in the first treatment group and acted as a "referee" during the simulation.

The next day students took the content achievement test in a similar manner to group one. The delayed posttest was again approximately six weeks after the first test.

The third treatment group was a noncomputer group. The students in this group (N=46) did a noncomputer pre-lab with two decks of 3x5 cards and the experimenter acting as the computer. A student would pick from one deck the name of an animal or plant that an animal in "Odell Woods" might meet. Students would vote on what to do and then the experimenter would read from another

card what the outcome was of the encounter.

The next day a similar arrangement was carried out for the "Odell Lake" simulation. In addition, however, overhead transparencies of the simulation screens were prepared by screen dumps to a printer and shown at appropriate points in the non-computer simulation. In this manner, each treatment retained some visual component. This group was tested in a similar manner as the earlier groups.

Data Source

The subjects for the study were sixth grade students in a combination 5th and 6th grade school of the Metropolitan Nashville (TN) Public Schools. The entire sixth grade class was included in the study.

The content achievement test on the science content of the study was an experimenter prepared instrument which contained two parts. The first part was nine multiple choice questions covering the concepts of the ecological simulation "Odell Lake". The second part of the test was an exercize to complete a "food pyramid" of the ecological setting of the simulation. Coefficient Alpha reliabilities were calculated for each subtest based upon the delayed posttest data. The reliability for the first subtest was 0.56 and for the second subtest 0.77.

Results

Table 1 summarizes the descriptive statistics for the immediate posttest across the three groups by sex for both sections of the test. Table 2 summarizes the delayed posttest. A 2x3 fixed effects analysis of variance was carried out on the data of Tables 1 and 2 and the results are presented in Tables 3

and 4.

Tables 1 through 4 About Here

The only statistically significant result in the immediate posttests was a difference in achievement on the multiple choice part of the test with male student performing better on the test than female students although a trend towards the group two (total class with computer) treatment was seen ($p=0.07$). No differences were found in part two of the test.

The delayed posttest shows an interesting interaction effect with females performing better than males in the second treatment group (total class with computer) but worse than males in the first treatment group (pairs on the computer) on the second part of the test. Little difference appears in treatment group three.

Discussion

The need for several microcomputers to run simulations on a small group basis appears not to be warranted by this study with some indication, although very tentative, that large group instruction may be slightly more benefical, especially for immediate measures. Larger differences between the treatments, especially between the computer vs. non-computer treatments, were probably not observed because of the non-computer treatment being very similar to the computer treatment. The non-computer treatment remained a simulation with the instructor drawing randomly from a set of cards to present situations. In addition, some of the graphics of the computer situation were retained in

the presentation. The addition of a "reading only" treatment to compare achievement with a non-simulation and non-graphical presentation might have produced clear differences between computer and non-computer treatements. This will be investigated in future research.

Differences between the sexes in achievement on the immediate recall content items can be addressed with aid of previous research. Malone (1981), in his study of computer games, did find some indication that boys had a higher preference for a version of a computer game that involved darts hitting ballons than girls. The alternative version did not have the dart hitting the ballons but indicated hits and misses by short lines. He interpreted this result as indicating that the "fantasy" component of such games may vary significantly between individuals and that the ability to chose the fantasy would be an important component in game development. In Odeli Lake, no variation in the graphic responses is possible. If the student makes a mistake, the student can be "eaten" by the other fish if it is a predator. This dramatic response may not be a appropriate fantasy for some students, especially females.

The interaction effect on the delayed posttest is somewhat more difficult to interpret. Girls were superior to boys in the group presentation but were less successful than boys in the two person per computer treatment. The group presentation method was closer to a normal class situation than the two person treatment, thus offering the girls a more familar environment. Observational notes on the two group situation did offer some indication that males were more likely to "take chances" in the

simulation. Such risk taking may have resulted in the males going through the simulation a larger number of times because of failures that resulted in the student being "eaten" and therefore having to repeat that particular fish.

Implications

Although this study involved a relatively small sample and outcome measures with relatively modest reliabilites, it does point towards the conclusion that group presentations of some simulations may be done instead of two group presentations without major differences in student ability to recall concepts of the simulation. This may be useful to teachers in schools with limited numbers of computers but have access to a large screen monitor and one machine. The differences between the sexes may be of less usefulness in that classroom teachers have little opportunity to provide instruction that is different for the sexes. Computer software can be reviewed, however, with this in mind and be introduced by the teacher in a different manner or not used if the "fantasy" component seems inappropriate for female students.

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Table 1

Descriptive Statistics on Immediate Posttest by Treatment Group and Sex

		Group					
		1		2		3	
		Male	Female	Male	Female	Male	Female
Subtest One	x =	5.67	4.79	6.29	5.96	6.42	5.45
	S.D.=	1.79	2.14	1.95	1.83	1.53	2.11
	N =	24	17	34	24	26	20
Subtest Two	x =	2.25	2.12	2.15	2.75	2.42	2.15
	S.D.=	1.80	1.69	1.74	2.17	2.10	1.84
	N =	24	17	34	24	26	20

Table 2

Descriptive Statistics on Delayed Posttest by Treatment Group and Sex

		Group					
		1		2		3	
		Male	Female	Male	Female	Male	Female
Subtest One	x =	4.70	5.35	5.47	5.21	5.92	5.25
	S.D.=	2.29	1.84	2.45	1.91	1.67	1.55
	N =	23	17	34	24	24	20
Subtest Two	x =	2.22	1.35	1.24	2.25	1.71	1.55
	S.D.=	1.76	1.58	1.44	2.03	1.65	1.10
	N =	23	17	34	24	24	20

Table 3

ANOVA on Immediate Posttests by Treatment Group and Sex

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. of F
Subtest 1					
Group	19.32	2	9.66	2.73	0.07
Sex	17.27	1	17.27	4.88	0.03
Group x Sex	3.12	2	1.56	0.44	0.65
Explained	39.54	5	7.91	2.24	0.05
Residual	491.71	139	3.54		
Total	531.24	144	3.69		
R^2=0.052					
Subtest 2					
Group	0.98	2	0.49	0.14	0.87
Sex	0.47	1	0.47	0.13	0.72
Group x Sex	5.66	2	2.83	0.78	0.46
Explained	7.11	5	1.42	0.39	0.85
Residual	503.93	139	3.63		
Total	511.03	144	3.55		
R^2=0.003					

Table 4

ANOVA on Delayed Posttests by Treatment Group and Sex

Subtest 1

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. of F
Group	8.73	2	4.36	1.06	0.35
Sex	0.59	1	0.59	0.14	0.71
Group x Sex	9.45	2	4.72	1.14	0.32
Explained	18.68	5	3.74	0.91	0.48
Residual	560.76	136	4.12		
Total	579.44	141	4.11		

$R^2=0.02$

Subtest 2

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. of F
Group	1.21	2	0.60	0.23	0.80
Sex	0.48	1	0.48	0.18	0.67
Group x Sex	21.58	2	10.79	4.12	0.02
Explained	23.26	5	4.65	1.78	0.12
Residual	356.32	136	2.62		
Total	379.58	141	2.69		

$R^2=0.004$